No. 141 July 2008

solplan review

the independent journal of energy conservation, building science & construction practice

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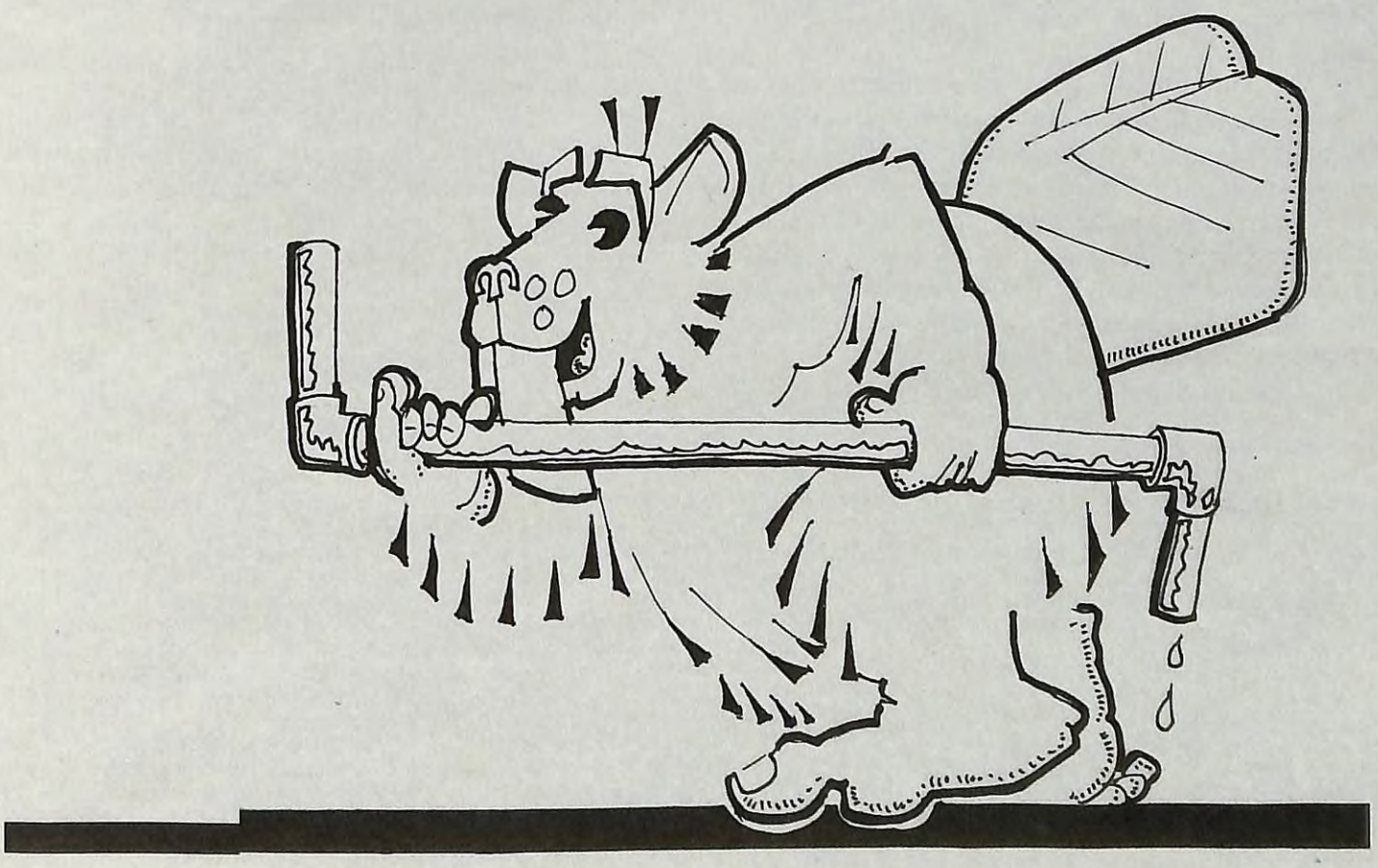
Making a Home Solar Ready



From the Editor . . .

Gardeners understand that the look and quality of garden plants depends on the type and quality of seeds planted long before the flowers and fruit mature. In other words, it means thinking ahead and long term planning.

This is not too far off the mark of what builders do. The building has to be designed, planned, and then the construction moves the process along, which itself has some lead time and planning.

The fact that we are now seeing shortages of labour can be attributed to a lack of foresight at how we have looked at the trades themselves. We have not made the investments in training, education, and recognition to encourage newcomers into the trades.

In a similar vein, it is outrageous to observe the antics of the national government and its agencies where professional participation or initiatives have been severely curtailed recently. In the housing sector we have an enviable history of study and research since the 1940s, especially through activities of the National Research Council and CMHC. Unfortunately, we have seen major cutbacks in recent years, which only seem to be accelerating in the past two years.

CMHC, the major force in Canadian housing and a major funding agency for housing research, has stepped back from supporting important fundamental building research, regardless of whether it is needed or not. And we certainly know that we don't know everything we need to know and there are certainly plenty of issues that need to be investigated – some practical research into specific issues that have arisen, and some basic, pure science investigations.

Most people understand that innovation doesn't appear out of thin air – it needs to be nurtured and the environment put into place to allow it to flourish. The gardener understands that to nourish the garden, it's not just a matter of planting plants and seeds, but the conditions have to be made right – the soil has to be nurtured and from time to time amended by addition of fertilizers and amendments to allow plants to flourish.

The same applies to human capital. It is a shame that the powers that be in the upper reaches of the Canadian government and its agencies don't seem to understand that or care not to. Then again, there hasn't been a lot of evidence that they read much of anything (other than perhaps dry accounting sheets), or understand the wonders of artistic and scientific investigation and how it benefits us all.

They don't understand that corporations do not have the ability nor capacity to deal with issues of a broad social benefit. That is what governments are there to do, as representatives of the community as a whole.

Unlike an automotive or appliance manufacturer, the building industry is dependent on this common societal support mechanism, because most companies are small and do not have the depth or breadth of resources to get involved in fundamental research.

The gardener understands that a prize-winning garden can't coast on its laurels forever – it needs ongoing work. The same applies to scientific, including building research. We can't just coast on the innovative work done in past decades. Activity needs to be maintained if not expanded.

Richard Kadulski,
Editor

solplan review
the independent journal of energy conservation, building science & construction practice

Editor-Publisher: Richard Kadulski
Illustrations: Terry Lyster
Contributors: Rob Dumont, Doug Tarry, Tex McLeod, Janet Ansell
ISSN: 0828-6574
Date of Issue: August 2008
SOLPLAN REVIEW is published 6 times per year by:
the drawing-room graphic services ltd.
PO Box 86627, North Vancouver, BC V7L 4L2
Tel: 604-689-1841 Fax: 604-689-1841
e-mail: solplan@shaw.ca
Street address:
#204 - 1037 West Broadway
Vancouver, BC V6H 1E3

Publications Mail Agreement No. 40013363
Postage paid in Vancouver, BC.
Return undeliverable Canadian addresses to
PO Box 86627, North Vancouver, BC V7L 4L2
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Making a Home Solar Ready

Solar water heating is an easy, practical and economical way to save on heating costs and reduce greenhouse gas emissions. Solar domestic water heating systems can reduce a home's greenhouse gas emissions by up to two tonnes per year.

A solar installation is much easier to do at any time if the building is solar ready. During construction or a major renovation, making a home ready to use solar energy can be easy and inexpensive, so that when the decision is made to install a solar water heater in the future, the installation can be done quite easily.

If a home is identified as being ready to accommodate a solar installation, it will be easier to motivate homeowners prepared to consider a solar installation to take the next step and install solar. That was the thinking behind a pilot project that NRCan initiated to develop a *solar ready* program. NRCan teamed up with Doug Tarry Homes of St. Thomas, Ontario to pilot to build 100 homes that were *solar ready*. The project's intention is to raise the profile for the potential of solar water heating as an option, even if it is not installed at the time of construction.

In the first group of 50 homes they built and marketed as solar ready, they found a lot of public interest in the concept, and a couple of purchasers opted to add a solar domestic water heating system right away.

Solar ready means preparing the house to make a solar installation easy. It also means reviewing and adjusting the design and site plan to allow for placement of solar equipment. Solar ready requires roughing in a pipe from the roof to the mechanical room so that solar water heating system installation is quick, clean and easy. It could also include installing a sensor wire.

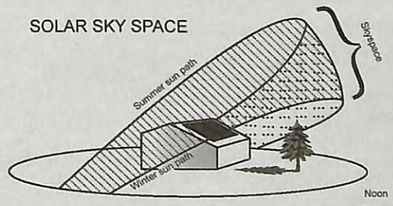
Many types of solar energy systems are available in Canada: solar water heating, solar space heating, and solar electric (photovoltaics). The focus of the *solar ready* initiative at this time is solar domestic hot water. Packaged solar domestic hot water systems can provide about 50% of the annual hot water requirements for a typical family home of 2-6 occupants – in the summer it will be a larger proportion, in the winter it will be less.

Steps to Make a Home Solar Ready

A roof space is needed for the solar hot water collectors. The south-facing area of the roof should have access to full sun to operate properly, and room for solar panels. Thus if the house is surrounded by tall trees, or is in a deep, narrow valley, the potential solar access is greatly reduced, and the house may not even be a candidate for solar. Depending on local climatic conditions, it may be possible to use east or west facing areas, although the performance is reduced.

Ideally, the roof should face south (or at least within ± 30° of due south). Ideally, the roof slope should be within 15° of the latitude of the house (i.e. for Vancouver 49° ±15, in Toronto 44° ±15, in Edmonton 53° ±15). However, no roof need be ruled out due to its slope as roof racks are available to adjust the angle of the solar collectors.

The typical roof area needed for a domestic hot water collector array will be about 10 x 12 ft. The location needs to be considered with the roof truss design to allow workspace for solar collector panel installation, hook up, and support for solar panel anchors. The weight of the panels with water may be 4-5 pounds per square foot,



The City of Vancouver has just revised their building code making *solar ready* installations mandatory for all new one and two unit dwellings in the City. The code change comes into effect September 5, 2008.

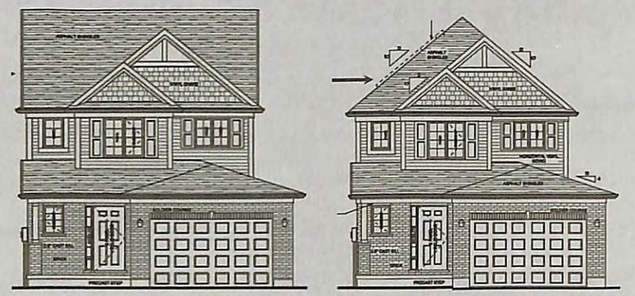
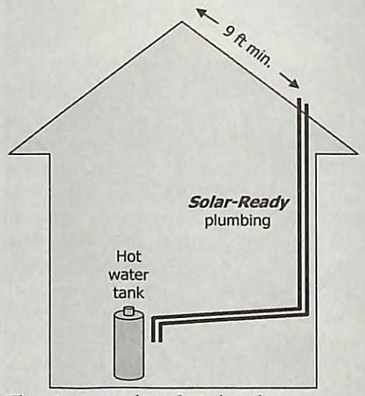


Fig. 1 Some adjustments to the home's roof design may need to be considered to create a south facing roof area. This is one example of a home with an east-west facing roof with south gables modified to create a roof area facing south.
(Doug Tarry Homes Ltd.)

so they generally do not need extra structural support.

To optimize the potential for solar, the home's roofline may need to be tweaked. Gable end roofs facing south or west don't work, and some redesign may be needed. Figure 1 shows an example of a roofline adjustment to allow a south-facing roof to be created.



The pipes are sloped so that the system can drain back into heated space. This provides automatic freeze protection and allows systems to operate year-round.
Taylor Munro Energy Systems Inc.

Layout of the Pipe Run

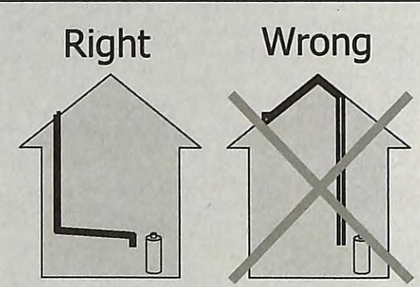
The pipe run or "chase" – where the pipes will be run between the roof and the utility room – should be as short and straight as possible.

Where the solar collectors are directly above the utility room or where horizontal pipe runs can be done in the attic or utility room, installing a straight "pipe chase" is the preferred method for making the home solar ready.

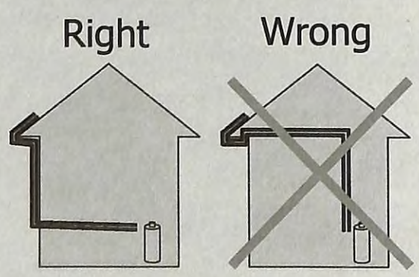
A single straight 4" pipe chase or two 2" pipe chases from the utility room to the roof space will allow the installation of the solar pipes and pipe insulation during solar system installation. The chase pipe(s) should be made of lightweight PVC such as solid sewer pipe. Simply leaving a boxed-in open space in the wall rather than installing an actual chase pipe is not recommended as other trades, unaware of the space's function, may inadvertently install wires and plumbing through it.

The chase should have caps installed on both ends and the chase sealed at the ceiling-attic penetration to maintain home air tightness and floor fire rating.

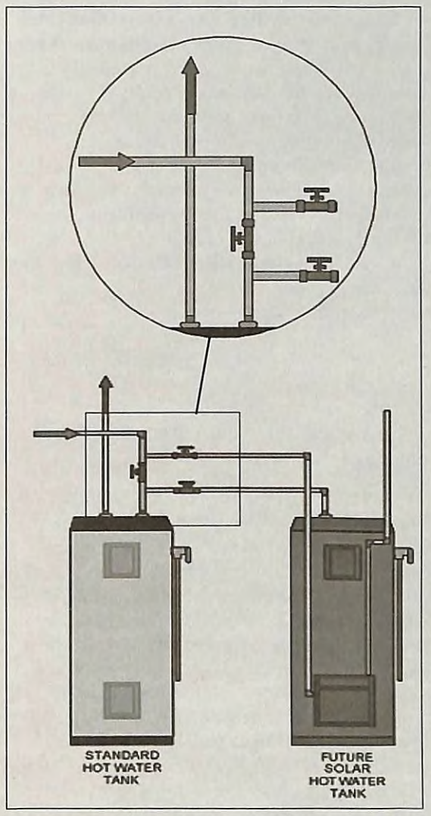
The preferred solar-ready design has one roof penetration for two pipes and control wire. If the mechanical room is at the other side of the house, the pipes need to go 'down and over', not 'up and over'.



If a roof penetration has to be avoided, the pipes and sensor wire can come out of a wall and up to the roof along the outside. However, the pipe must have a gravity path to the indoor mechanical space, and the pipes need to be well insulated.



Taylor Munro Energy Systems Inc.



Mechanical room

The utility room where the controls and solar hot water tank will be installed should be designed to accommodate the equipment. Roof and mechanical room layouts should show where future solar panel and solar hot water tank are preplanned, and be provided to the homeowner.

The plumbing should be laid out so that connections for a future solar hot water installation can be done easily. This means installing two "T" connections in the cold-water inlet pipe that brings cold water to the main water heater. Installing shut-off valves on each of the "T"s and one in the main pipe between the two "T"s will allow for quick connection of a future tank.

Place labels on the conduit termination in the mechanical room indicating the solar ready

(Doug Tarry Homes Ltd.)

R-2000

For information on the R-2000 Program, contact your local program office, or call
1-800-387-2000
www.R-2000.ca

Pre-plumbing for Solar Domestic Hot Water

Install a feed and return line and a sensor wire from the mechanical room to the south-facing roof. Ideally:

- Use two lines of ¾" insulated copper pipe.
- Use 14-gauge, 2-wire cable or a wire run with the piping. This will be used as the temperature sensor wire for the pump controller.
- Slope all plumbing to an indoor heated mechanical space.
- Penetrate the roof as low as possible (min. 9 ft from the edge) leaving room for the collector array to drain down into the feed and return pipes.
- Cap the roof penetration in accordance with local standards.
- Allocate space for the storage tank, preferably next to the hot water tank. Tanks can be round or rectangular and are typically as big or slightly bigger than conventional water heaters.

Some solar systems use an antifreeze solution as the heat transfer fluid running through the pipes and collectors. Others use water in a drain-back design whereby all the water returns to indoor heated space whenever the system is not circulating. In all cases, the system will need to be able to drain for proper operation and/or periodic maintenance, so the solar ready pipe run must have a 'gravity path' from the roof to the future solar storage tank location below.

The Canadian Solar Industries Association offers technical guidelines on making homes solar ready, and has Solar Ready Tags for solar ready projects. These tags are intended to be attached to the pipes or chase to remind future homeowners that their home is ready for a solar hot water system.

Information: *www.cansia.ca/solarready.asp*

Is There Enough Sun in Canada For Solar Energy?

We are seeing a resurgence of interest in the use of renewable energies. Solar energy is especially well suited for harnessing in buildings, yet many sceptics have the sense that as a northern country, there is not enough solar energy to be of use. This is especially the perception in regions like the cloudy maritime regions on the east and west coasts.

However, a review of the solar resource shows that areas where 90% of the population lives in Canada receive more solar radiation than Germany, which is the leading nation (in per capita terms) in the use of solar electricity or photovoltaic (PV) use.

Photovoltaic is the direct conversion of solar energy to electricity, not unlike the common solar cells used in calculators, and increasingly for road signs (especially the temporary construction message boards), parking meters, as well as recreational uses on boats and cottages.

Regions with similar or lower sunlight and similar cold winters such as Austria and Switzerland are world leaders in the use of solar water heating for combination systems (solar space heating plus domestic water). Regions where the purchasing power is very low (China) are also very big users of solar water heating.

With 3 to 5 kWh/m^2/day, Canada gets enough solar radiation for solar energy to be a technically viable proposition.

Why are we not seeing more use of solar energy in Canada?

Until recently, the price of energy has been extremely low, so energy concerns were not on the radar of most people. With the recent continuing change in oil and gas prices, more and more people, companies and governments are starting to look at alternatives. Also, in the past, few worried about environmental issues. Global warming was an unknown concept, or most people were in denial about it (including many in government). It is only recently that the majority of Canadians began to acknowledge that something has to be done, and a growing number are recognizing that clean energy, such as solar energy and other renewable energies, has an important role to play.

Proper selection of solar technologies can alleviate many energy and environmental problems as well as reduce out of pocket costs for the homeowner. ☼

How Much Does Solar Ready Cost?

Typical costs for *solar ready* are estimated to be in the range of $280 to $385. This breaks down as follows:

- $60 - $100 - plumber to install shut off valves
- $30 - $50 - electrician to add electrical outlets
- $150 - $180 - central Vac contractor to place 2 - 2" central vacuum conduits
- $35 - $50 design time per plan set to verify plans for simplified roof layout and conduit placement.
- Labels $5

Corporate Mergers: American Standard

American Standard has announced the merger of **American Standard**, **Crane Plumbing** Holding Corp. and **Eljer** Holding Corp. The new combined company is now conducting business under the name of American Standard Brands and will continue to market and support all existing brands in Canada.

This merger combines three major North American brands of bath and plumbing products. The announcement states that the merger will help improve their competitive position, although with a near monopoly, it is difficult to understand how the elimination of independent competing manufacturers will improve customer service and choice. These types of mergers reduce the customer's choice of products as product lines are eliminated in the interests of corporate efficiency, and 'improved efficiencies' mean operating efficiencies for the benefit of the company and not necessarily for the customer.

Anybody notice how easy it is to get a hold of knowledgeable technical staff at some of these large corporations? There was a time when most major building product manufacturers had technically competent representatives who were available to provide product support. Today, customer service is given lip service but little actual service. Companies seem to operate on the big box store concept – you either find what you are looking for on your own, or else tough, it's just not available.

Solar Home Design: Lessons from the Past

Academics tell us that we forget history at our peril. World events are often shaped by individuals and leaders who've not paid attention in history class. Just look at the mess that our current crop of politicians has got us into.

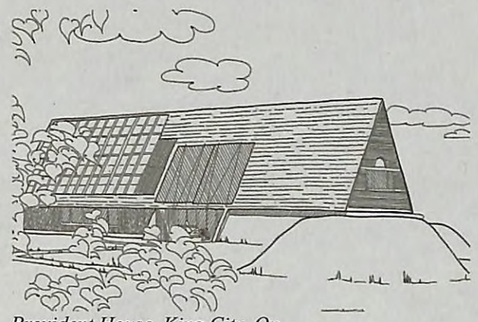
The same can be said about activities in all walks of life. The energy crisis of the 1970s generated a flurry of activity that included a number of demonstration projects that gave us a better understanding of building performance. They showed us we can build efficient homes, and what works and what doesn't work. The R-2000 program emerged at that time, underlining the importance of keeping in mind that a *house-is-a-system*, and that you cannot just look at materials and building components in isolation.

Although there was monitoring of the various demonstration projects, it was mostly short term monitoring – at most one or two years. Unfortunately, there has been little follow up over time to see how the buildings and systems being tried out perform over a longer period of time.

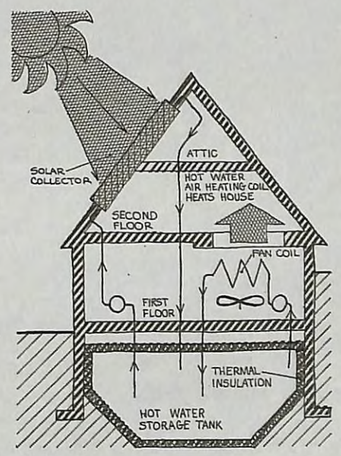
This is an unfortunate characteristic of the building industry – we seldom go back to projects to see what works how well, or even if it works as intended, so lessons learned are random. Usually we only go back and dissect a building when there is a serious problem, or when the problem is widespread enough to merit broad-based attention, as was the case with the building envelope problems on the West Coast (aka Leaky Condo problem).

In the 1970s, the initial approach to the quickly escalating cost of energy was to look at solar design. At the outset, a building's heat loss was calculated (labouriously by hand as personal computers were in their infancy), followed by what the available solar resource was at the site, and an appropriate area of solar collectors was added to the building. Soon, we learned that energy conservation for a passive solar design was the first thing to do. Improve insulation, draftproof the house, optimize window design, then look how much more energy is needed, and how best to provide it. Lessons learned from that time are especially important today as more and more designers and builders are looking at net-zero energy homes – homes that aim to be totally autonomous with no external energy needs.

Rob Dumont recently came across some documentation on one of the early Canadian solar demonstration projects – the Provident house in King City, just north of Toronto. The main feature of this house was seasonal thermal storage for captured solar energy. A large water tank was to store heat to supply it to the house over the year. The seasonal heat storage idea was promoted by the late Frank Hooper, an Ontario mechanical engineer, and was used in a number of projects.



Provident House, King City, On.



We haven't been able to locate detailed performance data on the Provident house. (If any reader has any information on this project, we'd love to hear from you).

Monitoring of similar seasonal storage projects showed that the main challenge was the amount of insulation required for the water reservoirs. The thermal storage requires extremely high insulation levels otherwise there is significant heat loss into the ground. ☼

Provident House Specifications

Heated floor area: 2792 sq.ft.
Window area: 223 sq.ft.
Heating: 100% solar heating – 60,000 gallon water reservoir, with a fan coil for forced warm air heat distribution.
Solar collectors: 717 sq.ft. for space heating; collector slope 50°
Domestic hot water: 80 sq.ft. solar collectors

The home was designed by John Hix, architect, and Frank Hooper did the mechanical engineering. It was built by McClintock Homes.

Recycling Residential Grey Water

Canada's per capita water consumption is 65% above the world average. The average Canadian uses more than 335 litres of fresh water per day. This is more than twice the average in France, three times in Germany, almost four times in Sweden, and more than eight times the average in Denmark.

Only 10% of our home water supply is used in the kitchen and as drinking water, while about 65% of indoor home water use occurs in our bathrooms – toilets being the single greatest water use. However, currently all water used in the home is treated to the highest drinking water quality even though most is simply flushed down the toilet.

In recent years there has been great interest in making use of grey water, because of concerns about dwindling reserves of water reservoirs and limited capacity of sewage treatment plants. Grey water is the wastewater generated by bathing, dish washing and laundry.

Some North American jurisdictions, especially in water short regions are now allowing some use of grey water, mostly for irrigation and toilets. However, many officials still have concerns about safety and potential contamination of clean drinking water.

Concerns about potential health and environmental risks means that many jurisdictions, if they permit grey water use, demand intensive treatment systems for it, making the cost higher than for fresh water.

Some green building programs are giving credit to grey water systems. Grey water recycling has been added to the Built Green checklist in BC and Alberta, and can earn as many as six points on the "Water Conservation" section of the checklist. Many of the current Equilibrium demonstration homes looked at making use of grey water to reduce their water load, but in most cases seem to have run into regulatory obstacles with hesitant local regulators.

Grey water is not something to consider lightly because of the contaminants present in the water. Grey water that is left untreated will become "black" water, or sewage, after a period as short as 24 hours. For safety reasons, the grey water must be treated so that it remains grey water.

A Canadian company has developed a residential scale package to filter grey water. The Brac System has patented components that filter particles from used water from the shower, bath and laundry for reuse in toilet flushing. The recycled grey water is only used for the toilet or irrigation and is plumbed such that it cannot contaminate the drinking water, but it reduces the volume of water consumed by the house. The Brac System can save 35% to 40% of annual water consumption, thus reducing the water bill.

While the Brac System filter captures particulate matter, the mechanics of the system do not "treat" the water, per se. The water still requires chemical treatment in order to keep bacteria and odours in check. There are also visual quality issues of the water to consider. Soap and detergents will remain in the water, giving a cloudy appearance, known as turbidity, to the water in the toilet bowl, but otherwise the toilet performs exactly as it should, just without the use of top quality treated water.

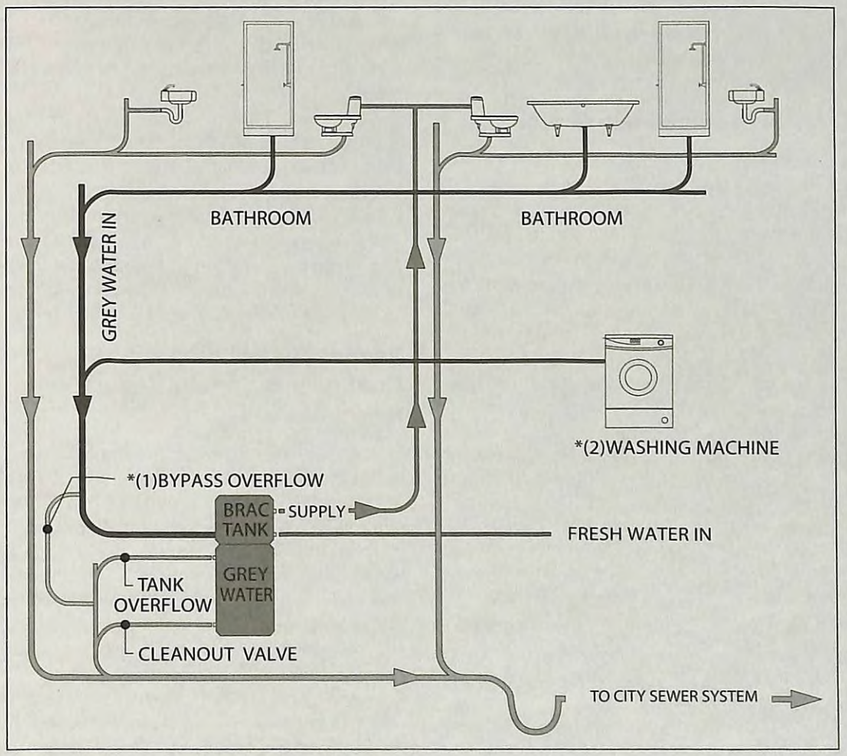
The unit has an integral pump and storage tank. The grey water enters and is filtered – the filter bag which is readily accessible, needs periodic cleaning to remove the solid mater that is caught. The water then passes into a small storage tank past a chlorine tablet (not unlike some used in swimming pools) that keeps bacterial activity in check.

The units fall into a grey area of the plumbing code which doesn't explicitly forbid grey water, nor allow it. And there are no provincial or federal governmental guidelines for installing or using grey water systems. Much still is at the discretion of the local authority having jurisdiction. A number of Canadian localities are allowing these units on a pilot basis. Cities that are facing severe water supply challenges are especially open to considering alternate water management systems.

In Langley, BC, a homeowner worked with the Township's environmental coordinator who coordinates the Township's wastewater program to stickhandle the design through the municipal departments as a pilot project. The city of Kelowna, which is facing severe water supply and sewage treatment issues because of the fast growth in a very dry area, has been an active player in a pilot project to monitor the performance of the system and even helped organize and publicize an open house to showcase the technology.

The Brac System is available in several sizes, from one for a single family residence, to commercial scale packages. The RGW-250, the most popular tank, is designed for homes with up to 6 people, has a tank capacity of 250 litres (66 US gallons) and retails for $2190. It is 110v/220v switchable and includes a long-lasting HDPE moulded shell, a 1/2 hp electronic control pressure boosting pump, , an electronic control water "make-up" system, and programmable electronic chlorination system. An extra filter and grey water pipe marking tape is also included.☼

Information:
Brac Greywater Recycling Systems
Montreal, Quebec
Tel: 514-856-2722
Fax: 514-856-2723
www.bracsystems.com



Canadian Home Builders' Association

Technical Research Committee News

Treated Wood

The 2005 National Building Code requires the use of treated wood in certain locations on a site. The treated wood must be labeled appropriately. However, treated wood that is properly labeled will not be available until 2009. The TRC also learned that new treatments that are less corrosive may soon enter the Canadian market. The Canadian Wood Council reported that research done recently at the University of Toronto has found a correlation between premature corrosion and the use of particular types of ACQ.

Over-the-Range Microwaves

The building code requires minimum vertical clearances above the range elements (or burners) on a stove. The requirement is for a minimum clearance of 600 mm to non-combustible elements. However, typical manufacturer's installation guidelines for over-the-range microwaves (OTRs) are between 400-500 mm, and have therefore been failed by City of Calgary inspectors for non-compliance with the code. The Alberta Building Technical Committee has recently ruled that OTRs can be considered to be a portable plug-in appliance, and therefore should not be required to conform to this code article. It is now acceptable to have clearances based on manufacturer's installation guidelines, which must be available at time of inspection for the inspector to review.

National Building Code Update

Many changes have been proposed for the next edition of the NBC in 2010. The proposed changes will be made available for public consultation in September 2008. There will be a long list of changes. Many will deal with relatively minor editorial or technical corrections, however, there are some more substantive issues being proposed. These include proposed new requirements for resistance to earthquake and high wind loads, design for radon mitigation, new window standards and increased fire safety between closely spaced houses.

The public review process allows anyone to take a detailed look at proposed changes and comment as to whether a change should be approved, altered, or rejected. The proposed changes will be posted on-line for a two-month period later this fall.

Energy Codes

As a result of the increased drive to introduce energy regulations into the building code by various jurisdictions across the country, CHBA has requested that the Canadian Code Commission update the Model National Energy Code for houses (MNECH) as a progeny document. This will require additional resources and provincial support.

CHBA would like to see this work expedited to provide a clear picture of current practice and to head off uncoordinated regulatory initiatives by provincial governments. For example, BC has added a new code objective making energy efficiency another basic objective to the code, in addition to the four main code objectives: safety, health, accessibility for persons with disabilities, and fire and structural protection of buildings.

Vancouver Building Bylaw Changes: Stringent New Energy Regulations

The City of Vancouver is determined to lead the way in Canada when it comes to green building standards. Recently adopted changes to the city's building bylaw (which is modeled on the National Building Code with local adjustments) will come into force September 5, 2008. The new energy standards applicable to new one- and two-unit dwelling homes will make new homes the most energy efficient code compliant in the country, especially when one considers that Vancouver has the mildest climate in Canada - 2950 degree days °C, and a January design temperature of -8°C (compared with Toronto - 4050 DDC and -20°C, or Calgary - 5200 DDC and -31°C).

The Technical Research Committee (TRC) is the industry's forum for the exchange of information on research and development in the housing sector.
Canadian Home Builders' Association, Suite 500, 150 Laurier Ave. West, Ottawa, Ont. K1P 5J4
Tel: (613) 230-3060
Fax: (613) 232-8214
e-mail: chba@chba.ca
www.chba.ca

The new requirements include:

- Exterior wall insulation: R-22 nominal
- Foundation walls (basements, heated crawlspaces): full height insulation, R-22 nominal
- Basement floors (heated or not): R-12
- Windows: maximum U-value of 2.00 W/K-m^2 (this is equivalent to an effective overall window R-value of 2.88)
- Light fixtures: at least 40% of hard-wired fixtures have to be units that will not accept incandescent or halogen lamps.
- Installation of an energy use display in the dwelling that is able to show electrical consumption on at least a monthly basis.
- Every dwelling unit must have a heat recovery ventilator installed in accordance with CSA F326 and it must be installed in an accessible location with a minimum headroom of 6.5 ft. (2 m).
- Hot water tank piping – the first 3 meters from a hot water tank, and 1 meter of the supply water line must be insulated. If the water system has a recirculation system, then all the pipes in the system must be insulated.
- Gas-fired fireplaces must be direct-vent with electronic ignition.
- Toilets must be dual flush, with a maximum flush of 6 litres.
- Every dwelling must have an Energuide rating. This will be required before an occupancy permit is issued. However, there is no requirement for the house to meet a specific target rating.
- Every dwelling must be solar ready for easy installation of solar collectors in the future.
- Each dwelling must be wired to allow for a future plug-in outlet for an electric vehicle.

The city plans to have a training and awareness campaign to help head off interpretation issues, as the wording seems to be hastily drafted. They will also be issuing interpretive bulletins to deal with some of the requirements. The expectation is that with these requirements, most houses will meet an Energuide rating of about 80.☼

Vancouver Building Bylaw Concerns

Vancouver's bylaw changes, done with relatively little notice, are going to challenge the building industry. Although these code change issues are of special interest in the City of Vancouver, the issues have a more universal application.

One of the major problematic changes is the mandatory requirement for HRVs in all new houses. Although the intention behind this requirement is laudable – to provide and maintain good indoor air quality by means of a continuous energy efficient ventilation strategy – there are going to be problems. Although HRVs are used in homes in Vancouver, they tend to be used only in high-end homes and R-2000 certified homes. The industry infrastructure is not in place for a sudden widespread requirement for HRV installations.

The current code ventilation requirements mirror the BC Building Code, which is an exhaust-only requirement with timer controls to permit operation a minimum of 8 hours per 24. Those standards were drafted as a compromise, to provide a reasonable air change in the house at a modest incremental cost. Proper HRV installations in accordance with CAN/CSA-F326 M91 ("Residential Mechanical Ventilation Systems") require trained installers, but not everyone in the mechanical industry in the region has the training.

Along with the limited trades capacity, there is also the question of how systems are going to be verified. Building officials as a rule do not do inspections of mechanical systems, other than perhaps very limited reviews of service hookups which is not the same. At this time, R-2000 is the only program that does measurements to verify HRV system performance and balance. In my experience doing R-2000 inspections, too often there are minor corrections needed, even when done by experienced installers.

Seeing the kinds of installations done in many non-R-2000 houses I believe that there will be many non-compliant systems that will not be corrected unless someone sets out to do inspections, which I suspect will not be done by the city.

Another major issue is a requirement that HRVs be "located in an accessible location within the dwelling unit, having a minimum headroom clearance of 2 m." Placing the equip-

ment in an accessible location is very important – I have seen too many HRVs placed in locations that will seldom get the required maintenance, and if the HRV filters are not cleaned 2, 3 or 4 times per year, they quickly plug up and are useless. However, insisting on a 2 m headroom (6.5 ft.) will create a big challenge. Furnaces and fan coils need servicing, and there is no similar restriction on their placement in the house.

Because of zoning requirements, to maximize on allowable floor area, many Vancouver houses are built with a finished basement that's at most about 1/3 the main floor area, and the rest has a 4-foot crawlspace, with the furnace typically placed in the crawlspace which is accessible from the staircase so that there is reasonably easy access for servicing.

That is where many R-2000 homes in the City have the HRV, in the crawlspace next to the furnace. Other accessible spaces can also include the kneewall spaces on an upper floor with a sloped roof. Since the city is basically built out, most new construction is on infill lots and the most common total floor area of a typical new house is under 2400 sq.ft. (including the basement floor area) so the wording will now impose serious challenges to ventilation system layout and home design.

There are some other HRV issues in the regulation, perhaps because of a lack of appreciation of the specific wording in referenced standards.

The requirement for solar ready installation lacks sufficient precision, which may well be covered by a supplementary bulletin. Any solar installation must have a roof surface accessible to the sun, but this is not made adequately clear. If the house roof has no solar accessible areas, or the house is in a location where it is in shade, there should be no need for this. The city has an aggressive urban tree preservation policy and bylaw, so there are residential locations where solar access is limited at best, rendering a solar system inappropriate.

The lesson for other regions is the importance of an open development process that allows input when technical and universally applicable regulations are drafted. A reasonable amount of time must be given to ensure that all stakeholders can participate in the drafting or commenting of the regulations. The wording in the Vancouver bylaw lacks the precision required of a regulation that must be used universally.

In general, I have no problems with the use of mandatory regulations to set minimum standards, but it must be recognized that regulations, unlike voluntary program standards, must be crisp and easy to follow by everyone. In voluntary programs, there is always room to manoeuvre and negotiate, but that is not the case in a building code. Although I am fully behind the intent of the changes made, there is a lot of ambiguity in the Vancouver bylaw.☼

Details on the changes are posted at:
www.vancouver.ca/greenhomes

Energy and Greenhouse Gas Performance of Canada's Residential Sector, 1990 to 2005

Even small, incremental steps in energy efficiency can have an impact over the long term. The home building industry has been improving energy efficient techniques for more than 25 years, spurred on at the outset by the launch of the R-2000 Initiative in the early 1980s, and continuing to this day.

Although the number of certified R-2000 homes may be modest, the impact of the program over this period has carried over into the mainstream. It has helped the evolution of conventional building practices and in the standards for many building components. Cumulatively, this has had a significant and positive impact on the energy and environmental performance of Canadian homes, both new and existing.

Between 1990 and 2005, energy use in Canada increased by nearly 22%, which has also led to a total greenhouse gas (GHG) emissions increase of 21.7% with the result that by the end of 2006, Canada's GHG emissions stood some 29% above the Kyoto target. However, during the same period, total GHG emissions from Canada's residential sector decreased by 8.5% despite a 28% growth in the housing stock through the end of 2006. This reflects an average 15% decrease in energy use per home.

Overall, the net impact of energy efficiency gains in the residential sector cut projected growth of energy use in homes by two-thirds between 1990 and 2005. GHG emissions from energy consumed in homes varied regionally, but fell in all provinces on a per household basis by between 10% and 60%.

The results achieved by the residential sector were achieved through improvements of many discrete components and systems. Each on their own may not amount to much, but cumulatively they add up to significant improvements.

Net-Zero Energy Home Awards

Housing is responsible for 17% of energy use and 16% of greenhouse gas emissions in Canada. Addressing the way we use and consume energy in the home is essential as we move toward truly sustainable community development.

Builders across Canada are already recognizing the need and importance for building homes that consume significantly less energy than typical energy efficient models while at the same time providing consumers with the tools for choosing and using onsite renewable energy. Recognizing and honoring this emerging trend in the builder community is important as there is a program vacuum above R-2000 that makes it difficult for near net-zero and net-zero energy home innovations to be recognized.

To help advance the market and accelerate the deployment of energy efficient net-zero energy homes in Canada, the Net-Zero Energy Home (NZEH) Coalition has developed the Net-Zero-Energy Home Award to recognize and celebrate the integration of renewable energy and energy efficiency in the residential construction industry. The award event will recognize those builders who are responding to a changing marketplace, one that is increasingly influenced by concerns for energy security and climate change.

Awards will be given under four categories:

- **"closest to net-zero"** retrofit project of the year;
- **"closest to net-zero energy"** custom builder of the year;
- **"closest to net-zero energy"** production builder of the year;
- **Net-Zero Energy Home champion** of the year.

A net-zero energy home integrates advanced energy efficiency design and building materials with onsite renewable energy, which is then capable of producing an annual output of energy that is equal to the total amount of its annual purchased energy.

Projects will be assessed on their ability to approach or reach net-zero energy. Entries will also be judged on the basis of several features, including repeatability, affordability, and potential for market transformation. To be eligible for the award, which is open to projects across Canada, projects must have verifiable data to substantiate their information.

Entries are due no later than March 2009. The Net-Zero Energy Home Awards will be made in Toronto in June 2009.

Entry details will be posted shortly on the Net Zero Energy Coalition web site:
www.netzeroenergyhome.ca

Exhaust penetrations

We try to build the house with a very airtight envelope, and then we penetrate the exterior with exhaust hoods and other penetrations. Look at any new house and you will find a bunch of penetrations scattered all over the wall. We seldom give enough attention to the design and location of service penetrations.
This is a new house under construction in Vancouver where the builder took great care to have all the exhaust hoods designed and lined up carefully and put discreetly on the side of the house.

Indoor Air Quality And Low Emission Finish Materials

Our image of pollution typically is the outdoor scene with smoke and particulates coloring the air in a haze of smog. Images of Los Angeles, Beijing, or early twentieth-century industrial cities come to mind, as does the infamous London smog in 1952 that lasted for 4 days and led to the death of thousands of people. However, the fact is that the air indoors could be worse. The US Environmental Protection Agency has stated that indoor air is often many times more polluted than outdoor air and is considered among the top five hazards to human health.

Indoor air quality is affected because we have changed the way be build new buildings. They are increasingly more energy efficient, but at the same time a combination of operating systems and new materials means that many buildings have poor indoor air quality when they have not been properly detailed or commissioned. Healthier, better indoor air quality requires minimizing harmful chemical pollutants indoors.

There are many causes for poor indoor air quality. They include interior moulds and bacteria and a number of volatile organic compound (V0Cs) found in nearly all building materials and household furnishings.

VOCs are found in materials including paints, glues and caulks and fuels. They are also in pesticides, office equipment such as copiers and printers, correction fluids and carbonless copy paper, graphics and craft materials including glues and adhesives, and even in permanent markers. They are present in furniture and widely used as ingredients in household cleaners, disinfectants, cosmetics, degreasers and hobby products.

Even traditional seemingly inert materials can contribute to indoor air quality problems. For more than forty years nearly all the homes in North America have used drywall as the main interior finishing material. Unlike the traditional hand-troweled plasters of yesteryear, the drywall surface basically consists of paper on gypsum. Given the right conditions, which often exist in a home, the paper surface is also an excellent medium for mould and bacteria growth.

Just because a material is manufactured from natural materials with low emissions will not guarantee better indoor air quality.

The conventional method of construction and finishing the gypsum board can reduce the ability of moisture migration and drying to take place, thus leading to moisture build up, providing ideal conditions for mould growth. This is especially a problem when there is poorly designed and installed mechanical ventilation.

New low emissions materials are appearing on the market, touting low emissions and implying that that alone will lead to better indoor air quality. It is unfortunate that their marketing materials confuse air tightness of building envelopes with air change and moisture levels within the home. Just because a material is manufactured from natural materials with low emissions will not guarantee better indoor air quality. It may help towards providing a better environment by reducing the quantity of contaminants built-in, but it still needs to be considered as part of the whole system, including the building's air change.

A recently developed wall coating material, Everwall Green, touts itself as an "active wall treatment for healthier air". The product with all natural materials and few synthetic chemicals, provides what looks like an attractive VOC-free plaster interior finish.

Unfortunately, the manufacturer's literature promotes the product as a 'humidity regulator' with odor canceling features. It is also evident that they do not fully appreciate the difference between air barriers and vapour barriers, stressing the importance of 'breathing' walls and not identifying the importance of the design of the building as a whole. They imply that the appropriate interior finish (their's) alone will resolve most problems of poor air quality by treating indoor contaminants.

The publicity material implies that a building with mechanical ventilation is bad. They suggest that buildings need to 'breathe' but don't realize that is precisely what mechanical ventilation provides, and very efficiently. They make references to traditional vernacular construction in other parts of the world which is not suited to the harsh climate conditions of most of Canada.

We don't mean to pan the product, which does seem to provide an attractive, low emissions interior finish. However, their rationalizations and marketing messages, trying to cash in on 'green' concerns, are very misleading and imply attributes of their material that are simply not appropriate. Any home needs to be considered as a whole system, which includes not only materials but also home design and its mechanical systems.☼

Information:
Everwall Green – *www.everwallgreen.com*

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Why do they do it?

I came across this furnace installation in a new home – the unit has the required condensate drain for the flue gases. All looks neat and tidy – until you realize that the condensate drain pipe blocks the access panel to the filter. Did anyone stop to think about what they were doing?

Building Science Insight Seminar Series

Every year, NRC-IRC presents seminars that provide design and construction professionals with practical information on a topic of broad interest, focused on technical advances related to a specific topic, including the results of recent NRC-IRC research. The 2008-09 series will focus on single and multi-family houses. It will address the important roles that ventilation and heating systems, high-performance windows, fire resistant components, acoustic separations and liveable basements play in forming an integrated system to achieve high performance low-rise buildings.

This one-day seminar will be held in the following locations:

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Vancouver, Oct. 6, 2008
Whitehorse, Oct. 8. 2008
Toronto, Nov. 4, 2008
Iqaluit, Nov. 6, 2008
Winnipeg, Nov. 17, 2008
Calgary, Nov. 19, 2008
Saskatoon, Nov. 21, 2008
St. John's, Dec. 2, 2008
Halifax, Dec. 4, 2008
Moncton*, Jan. 13, 2009
Ottawa*, Jan. 15, 2008
Quebec, Feb.3, 2009 (in French)
Montreal*, Feb. 5, 2009 (in French)
* With simultaneous translation

Information and on-line registration at the IRC website:
http://irc.nrc-cnrc.gc.ca/pubs/bsi

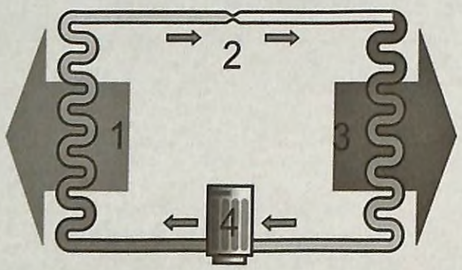
Energy Answers

Rob Dumont

What is your opinion about residential ground source heat pumps when used in provinces that get most of their energy from fossil fuels?

Let me start by going over how a ground source heat pump works.

A ground source heat pump is a device that transfers heat from the ground using electricity. You put electricity in and heat is transferred by a refrigerant that goes through a refrigerant cycle using a compressor, condenser, expansion valve and an evaporator. Heat extracted from the ground in the evaporator (or by a ground loop that is connected to the evaporator) is transferred to the condenser inside the residence. The ground source heat pump does not "create" heat, it merely transfers heat from the ground into the residence. The heat removed from the soil causes the exterior ground to cool off. Heat enters the ground in the summer and the annual cycle is repeated. A good ground source heat pump installation should put out about 3 kilowatt-hours of heat for every 1 kilowatt-hour of electricity input.



(Source: Wikipedia.org)

Schematic of a Heat Pump.
1= condenser, where heat is released, and the refrigerant gas is converted to a liquid
2= expansion valve
3= evaporator, where heat is picked up (cold is released)
4= compressor for the refrigerant gas

In cold climates, ground source heat pumps generally work better than air source heat pumps for the following reason. On an annual basis, the temperature of the ground is roughly the same as the air temperature. Here in Saskatoon, our average annual air temperature is about 2.2 ˚C, and the average annual ground temperature is about 6.2 ˚C at a depth of 1.5 metres, or a difference of 4.0 ˚C.

The reason that the ground temperature is higher than the air temperature is that snow in the winter acts as an insulator. In parts of the world where snow does not fall, the average annual air and ground temperatures are closer together. For example, in Vancouver the average annual air temperature is about 10.1 ˚C and the annual average ground temperature at a depth of 1.5 metres is about 11.3 ˚C, for a difference of 1.4 ˚C. Vancouver gets much less snow — 48.2 cm per year than Saskatoon, which receives about 97.2 cm. In addition, snow is on the ground for a much longer period in Saskatoon than in Vancouver.

If an air source heat pump were used in Saskatoon, it would have to pump heat from outdoor air, which averages about -17 ˚C in January. As mentioned above, the ground source heat pump in Saskatoon only has to pump heat from soil which is at about +6 ˚C.

If ground source heat pumps are so efficient, why doesn't everyone use them instead of electric resistance heaters?

First, cost and maintenance are the issues. Ground source heat pumps cost a lot more than baseboard heaters. A rough cost for a ground source heat pump for a modest detached house with suitable soil conditions can be in the range of $15,000 to $30,000.

A second issue is maintenance. A ground source heat pump has pumps, fans and a refrigeration compressor, all of which have moving parts and the accompanying maintenance.

Will you save money on energy costs if you use a ground source heat pump in place of a high efficiency natural gas furnace?

The answer depends a lot on the relative prices of electricity and natural gas. In Saskatchewan the price of natural gas is about 1/3 the price of electricity. With a ground source heat pump with a coefficient of performance equal to 3, the cost of energy for heating in Saskatchewan would be the same whether you used a high efficiency natural gas furnace or a ground source heat pump powered by electricity. In provinces where electricity is cheaper and natural gas is more expensive, the energy costs for the ground source heat pump would be comparatively lower.

A number of provinces in Canada, including Alberta, Saskatchewan and Nova Scotia, primarily use fossil fuels such as coal to generate electricity.

Assuming that you do not have natural gas in your area, would it make good sense to install a ground source heat pump in a new home?

An alternative that I would recommend would be to take the money that might go into a ground source heat pump and put it into improving the insulation of the house, improving windows, using passive solar gain, using a drain water heat exchanger, energy efficient appliances, compact fluorescent lighting, etc. In other words, optimize the energy conservation potential of the house to reduce the heat load of the house.

An advantage of the energy conservation route is that usually there are no moving parts associated with insulation. For most houses, the energy conservation route will also be less expensive than the ground source heat pump over the life cycle of the house.☼

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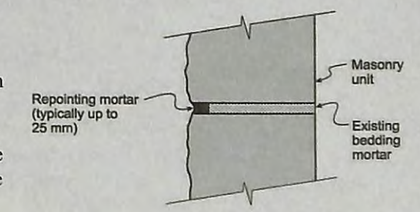
Key Elements for Proper Repointing of Older Masonry

Masonry buildings built before the 1940s make up much of the inventory of older buildings in Canada. Large building complexes such as hospitals, university buildings and landmark buildings down to small buildings such as houses and cottages have been built with massive masonry walls. The building technology and materials in those days were different from modern construction. For this reason, conservation of these older structures requires an appreciation of the techniques of the past. Improper use of repointing techniques can lead to permanent damage: degradation of the masonry units, erosion and spalling of the mortar; and discoloration and disfigurement of the masonry façade.

Fortunately knowledge related to proper repointing of older masonry joints has expanded in the last decades. The following is a basic primer outlining some of the key considerations for proper repointing of older masonry, intended to improve performance and the durability while at the same time attempting to maintain the architectural quality of older masonry for many decades to come.

Before Proceeding: First Things First

- Conduct a condition assessment survey of the building so that repairs, maintenance and conservation work can be prioritized. For instance, roof leaks into the masonry or unstable foundations should be fixed prior to repointing above grade masonry.
- Assess the types of environmental loads acting on the different elements of masonry. Moisture is an important one. Corrective interventions to minimize moisture loads on the masonry can go a long way in reducing freeze-thaw damage and erosion of mortar and masonry units.
- Evaluate whether a conservation specialist should be involved in the project, based on the project complexity and the historic value of the building.



Repointing involves removing the outer damaged layer of mortar and replacing it with new mortar

At the Design Stage: Selecting the Mortar Mix

- Mortar mixes widely available for new masonry construction may be too high in compressive strength and too impermeable for accommodating adequately the characteristics of older masonry assemblies. The repointing of older masonry buildings typically involves the use of low-strength mortars. A lower-strength mortar will tend to be soft or more flexible, a

property that permits it to be "sacrificial"; such mortar will absorb the stresses imposed on the assembly and undergo the potential resulting damage, protecting the masonry units themselves from damage. Lower-strength mortars also tend to be more breathable, promoting drying through the joints (many older masonry wall systems do not include a drainage cavity behind the exterior facing, and drying can only take place through evaporation).

- A repointing mortar should be 1) compatible with the properties of the masonry units 2) resistant to agents of deterioration likely to cause premature failure 3) compatible with the heritage character of the building.
- A single mortar mix suitable for all types of older masonry assemblies and Canadian climates does not exist. In fact more than one mix may be used on a single project to address the specific conditions encountered.

At the Construction Stage: Every Step Counts

- Select a qualified contractor experienced in masonry conservation work, and employing workers with appropriate training. Lower strength mortars are less forgiving of poor construction practices than mortars used in modern masonry. The best mortar mix for the job may perform poorly because of inadequate execution and curing practices.
- Several steps are involved: preparation of the masonry joints, and mortar mixing, application and curing. The main performance objective of these tasks is to obtain a mortar that is well bonded to the masonry units and the bedding mortar with little or no shrinkage cracks.
  - *Joint Preparation*. The joint should be raked and cleaned to get a clear rectangular space for placing the fresh repointing mortar. Using power tools to remove existing mortar can damage the masonry. Before using power tools, a test should be carried out to confirm the procedure and the operator's experience. Power tools may be useful to initiate the removal of old mortar – cutting out the center of the joint – and then chisels can be used to clean the mortar against the masonry units.
  - *Mortar Mixing*: Important considerations include controlling/monitoring the moisture content of the sand, adopting a consistent procedure for measuring ingredients, and controlling the amount of water in the mix to obtain a workable mix. A drier but workable–mortar (as opposed to wetter mixes typically used in new construction) is cleaner to work with, can be compacted into the joints better, and will be less prone to shrinkage during curing.
  - *Mortar Application*: Wetting the joint prior to mortar application, proper compaction of the mortar into the joint, ensuring the masonry units do not get smeared, and clean finishing of the joint are critical steps.
  - *Mortar Curing*: Rapid drying of the mortar should be avoided (it can lead to shrinkage cracks and water ingress paths). Protecting fresh low-strength mortar joints from rain, wind and sun and keeping them damp for 3 to 7 days is important. Avoid mortar application (where possible) during the cold season.
  - *Quality Control*: Inspecting and supervising at each step of the process is important to ensure good performance, as quality workmanship is much more important with low-strength mortars. Workability tests can be conducted to ensure specifications are met and quality consistency is obtained.

During Service Life: Providing TLC

Vigilance through regular visual inspections for signs of deterioration and prompt maintenance can do wonders to extend the service of the masonry. Keeping detailed records of the conservation work done on the masonry will be of great assistance for the next round of masonry conservation work- hopefully several decades from now.

More detailed information is available in the following two recently published NRC-IRC ***Construction Technology Updates*** briefs available on the NRC website at *http://irc.nrc-cnrc.gc.ca/pubs/ctus/index_e.html*

"Repointing Mortars for Older Masonry Buildings - Design Considerations" and "Repointing Mortars for Older Masonry Buildings - Site Considerations".

Polyisocyanurate (ISO) Foam Insulation Boards

In North America, more than 50% of low slope roofing applications use faced rigid polyisocyanurate (ISO) board as thermal insulation. It is also used occasionally in residential construction, especially in locations that require a high R-value subject to higher temperatures.

Although ISO boards are manufactured and tested in accordance with the applicable ASTM standard covering ISO boards, there are some questions about whether the standard itself adequately addresses dimensional stability, thermal resistance and compressive strength. The National Research Council conducted some tests on ISO boards to determine whether the standard is adequate or if more research and refinement is needed.

The study found that the dimensional changes in the ISO boards exposed to more extreme environmental conditions – high temperature (70°C) and humidity (78%) – appear to be greater in the direction perpendicular to the knit-line on the foam board surface and linearly related with the size of the specimens. At these conditions the compressive strength of the ISO board is also reduced, although just hotter temperatures increase the compressive strength – enough to warrant a more detailed review.

There is also a concern that allowable 2% shrinkage or expansion amounts to almost 2" on the length of a 4x8 sheet of ISO board. This amount of dimensional change is not something that many builders are aware of.

The R-value does decrease, but very slightly and is still slightly higher than the R-5.3 specified in the ASTM standard.

Critical Evaluation of Existing Specifications for Polyisocyanurate (ISO) Foam Insulation Boards in Roofing Applications *by Phalguni Mukhopadhyaya, Bas Baskaran, Nicole Normandin, John Lackey and Sebastian Evoniak*
Nationla Research Council Document: NRCC-50079

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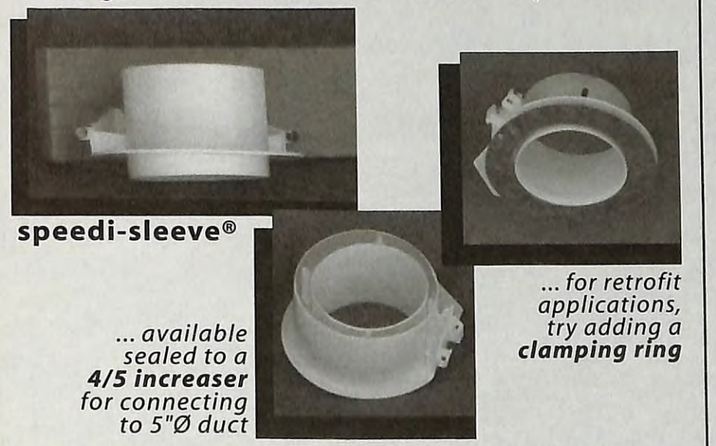
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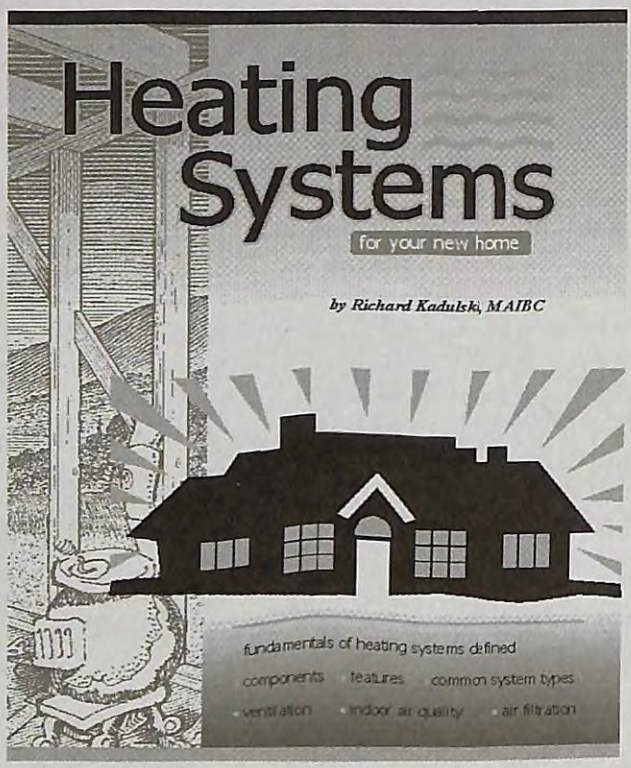

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